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Procedia - Social and Behavioral Sciences 48 (2012) 1493 – 1504

Procedia
Social and Behavioral Sciences

Transport Research Arena – Europe 2012

Mobility towards homogenization? A synthetic overview through multivariate analysis

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Abstract

This paper is investigating the main determiners of mobility behaviours and their long-term stability through a synthetic approach based on factor analysis. Principal component analysis is applied to mobility behaviours, pictured through a vector of trip intensities. Comparative analysis of national transport surveys reveals a trend towards homogenization of mobility levels, with respect to traditional socio-demographic variables, land use patterns and conditions of access to mobility. As a result, the main factor of mobility behaviours becomes qualitative and may be described in terms of lifestyles and modal split contrasting motorized, peripheric, and alternative, urban, mobility.

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Mobility behaviours; factor analysis; variability; homogenization; lifestyles; modal split.

1. Introduction

Analyses about mobility behaviours usually separate short- from long-distance mobility. Short distance mobility includes most of daily, regular trips such as house-to-work, shopping or children school accompanying, usually within urban areas. Long-distance mobility, on the contrary, includes most of occasional trips for leisure, holiday or social relationships, and also professional meetings. Moreover, long distance travelling usually comes out from built-up areas. Thus, short and long distance mobility differ not only by distances, but also by trajectories, frequencies, and purposes. Definitions of short and

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long distance trips may vary from one country to another [Bonnell & Armoogum, 2005]; however, the border is usually set to 80 or 100 km. In France, this dichotomy is notably reproduced by National Transport Surveys where the limit was set to 80 km. Results from last National Transport Survey (2007/2008) about current trends in short- and long-distance mobility behaviours were published as separate articles in a collective opus led by the French Ministry of Ecology, Sustainable Development, Transport and Housing [CGDD, 2010].

However, previous works underlined growing porosity between short- and long-distance mobility [Orfeuill & Soleyret, 2002]. In particular, long-distance commuting trips, notably with seasonal train tickets, are becoming more common: for instance, we estimate from National Transport Surveys that between 1994 and 2008, they have increased from 17,8 to 23,8 million yearly trips, representing a 33,7 % growth (to be compared to a 22 % growth, all purposes included). In order to study the main dimensions and determiners of mobility behaviours today, and how they are changing through long-term periods, it might be interesting to consider individual mobility as a whole, without making *a priori* distinctions between short and long-distance trips. Some attempts have already been made to overcome this distinction [Maffre & Volatier, 1998], where global mobility profiles were established from National Transport Surveys in 1982 and 1994.

Previous analysis realized on either short or long-distance mobility underline strong trends:

- Adjustment from mobility levels among workmen, low-income households, the retired, and inhabitants of low-density areas, who are catching up highly mobile social groups.
- On the contrary, stabilization, and even slightly decreasing mobility levels, among executives, high-income households, workers, inhabitants of high-density areas,.

In fact, such trends are mainly true for car use, representing the major part of individual mobility. Train, plane and transit follow different trends. For instance, differences in train mobility with respect to socio-economic position are increasing, especially for professional trips. However, as the general trend is determined by car use, there is some evidence of homogenization in mobility levels, at least as far as the influence of socio-demographics or land use patterns is concerned. Indeed, it doesn't mean *a priori* that variability within mobility behaviours is declining, because hidden factors that are part of unobserved heterogeneity such as attitudes or preferences could bring greater variability in mobility behaviours. Factor analysis, taking into account all variability through individuals, can help analysing global change in variability of mobility behaviours.

Strong statements could explain trends towards homogenisation, some of which are already well established, some others requiring to be confirmed and strengthened by further investigation:

- Generalization of driving license holding and correlated diffusion of car ownership explains adjustment of mobility levels among retired people, women, and workmen.
- Transition towards new mobility behaviours among the young and highly qualified living in metropolitan areas such as Paris, which could be qualified by rationalization in the relationship to various travel modes. More exactly, car could have partly lost its symbolic and patrimonial status to become a complementary tool to alternative modes to ensure given mobility services, and would gradually concentrate on necessary trips such as house-to-work.

Indeed, analysis made on car ownership, short-distance and long-distance mobility shows that car use and modal split follow opposite trends between inhabitants of low-density, periferic, and high-density, central areas. Car ownership and use (measured either by trip frequencies or travelled distances) keep on

increasing in peripheric crowns of urban areas and small cities, whereas it declines in central cities and their close suburbs within metropolitan areas.

Generally speaking, trends towards homogenisation suggest that explanatory factors of individual mobility might not be of constant influence through long-term periods. Alternative approaches based on econometric models [Madre & Gardes, 2005] also provide evidence of significative changes in explanatory factors from estimation of elasticities. For instance, income elasticities of transport demand and mobility are declining [coll. op., IFSTTAR, 2011]. As a result, the main dimensions of variability within mobility behaviours might also change: are they still quantitative, or have they become qualitative with market saturation ?

2. Methodology: synthetically describing mobility behaviours through multivariate analysis

The methodology of this study is inspired from previous works [Maffre & Volatier, 1998]. Instead of classic modelling approaches, techniques of multidimensional analysis were performed on data from the last French National Transport Surveys in 1994 and 2008. Through graphic representations, multidimensional analysis simultaneously allows to describe the main dimensions of variability within mobility behaviours, that are called *principal components* or *factors*, and to provide evidence of the main explanatory factors through observed correlations between principal components and illustrative variables. Active variables are mobility indicators, whereas illustrative variables are descriptors of individuals and households to which they belong, such as socio-demographics (income, qualifications, sex, age, work participation...), land use patterns, residential location (size of urban area, central/periferic), and mobility potential (car ownership, driving license holding, transit seasonal tickets...). Illustrative variables don't participate to the shaping of factors, but help interpreting their meaning.

Describing mobility by its principal components is equivalent to describing it by original descriptors; however, the interest of principal components is to synthesize information, and to allow graphic positioning. Mobility behaviours were analysed through a two-stage process:

- In the first step, all variables were transformed into qualitative variables in order to process multiple correspondence analysis on trips described by travelled distance, duration, mode, purpose, type of departure day (week or weekend...), type of departure hour (morning peak, evening peak or off-peak). Trip classification is then derived from hierarchical clustering.
- In the second step, individual mobilities are described by a vector of intensities in previously established trip profiles. Principal component analysis is then applied to intensity vectors, to highlight the main dimensions of variability within mobility behaviours and their correlation with illustrative variables.

It is possible to describe individual mobility profiles in 2008 as the same 18 600 individuals were asked about both their short- and long-distance trips. On the contrary, in 1994, separate sub samples were drawn out: in only a restrained sub sample of about 7 600 households, the same individuals were asked about both short- and long-distance trips. Moreover, the sub sample was biased because separate drawings led to over-representation of singles, more likely to be drawn out twice. Thus, specific corrective weightings had to be applied to ensure global representativity of the restrained sub sample.

Some other issues had to be considered in order to ensure comparability between successive surveys:

- Distinct peak hours were calculated in 1994 and 2008. Indeed, the morning peak remained stable between 7 h 30 and 9 h, but the evening peak begins earlier in 2008, at 16 h instead of 17 h.
- In 1994, individuals weren't asked about their weekend walking trips. To allow comparability, weekend walking trips were re-introduced in 1994 trip sample.
- Multidimensional analysis cannot be performed with missing values. Elimination of observations containing missing values minimized the weight of very long-distance trips (more than 400 km) in 2008, as information about departure time and travel duration was very often missing. To ensure comparability, a similar bias was introduced in the sample from 1994.

Trips had to be weighted. The weighting vector is obtained by multiplying sampling weights, ensuring representativeness, by travelled distances, in order to balance the influence of long-distance trips in factor shaping. Furthermore, short- and long-distance trips were compared on a common temporal basis of thirteen weeks by applying adequate multipliers to sample weightings.

Strictly speaking, profiles calculated through automatic classification cannot be considered as individual mobility profiles. They are, indeed, estimators of mobility profiles with a strong random component, dependent on the period of data collection. They represent, in fact, trips during last weekday, last weekend and long-distance trips during the three last months. To have an exact depiction of mobility profiles, it would be necessary to collect data on a widespread period (one week for short-distance trips and one year for long-distance trips). However, trip probabilities in the period of data collection depend on statistically significant influences of explanatory variables, and multidimensional analysis highlights rich and meaningful results about mobility behaviours, as we will see in the next chapter.

3. Results of 2008 survey

Not surprisingly, the main factor of trip variability is quantitative, opposing very short neighbourhood walking trips to very long-distant trips by high-speed train or plane. It is simultaneously an axis of distance, duration, speed and mode, which are strongly correlated. The second dimension opposes "extreme" trips where alternative modes are frequently used, to trips on average distances mainly realized by car or urban transport, typically house-to-work.

Table 1. Trip typology in 2008 resulting from hierarchical clustering

Type n°	Type label	Associated modalities (in decreasing order)
1	Motorized proximity trips (1-8 km) for personal purposes	Proximity, < 15 mn, car, shopping, accompanying.
2	Sunday promenades by soft modes	Leisure, proximity, cycling, Sunday, walking.
3	Transit trips	Light and heavy transit, internal to built-up areas, house-to-work, proximity.
4	Motorized short-scale (8-20 km) trips	Short-scale, car, 15-30 mn, interurban.
5	Local trips (20-80 km)	Local, car, countryside to urban areas, urban to built-up areas.
6	Neighbourhood trips (<1 km)	Neighbourhood, walking, cycling, < 15 mn, shopping, health, house-to-work.
7	Long-distance trips (80 to 400 km)	Long-distance, 1-2 h, 2-4 h, visits to relatives, holidays, and car.
8	Very long-distance trips (> 400 km)	Very long distance, holidays.

The partition above into eight classes was established after hierarchical clustering followed by optimal segmentation of the classification tree. Labels attributed to trip types only reflect the dominating aspects of each class; it doesn't mean that all trips of class 1, for instance, are of proximity and motorized, but that "proximity" and "car" are the most specifically associated modalities. Classification is consistent with multiple correspondence analysis, the main variable of trip segmentation being travelled distance, which is explaining most of trip variability.

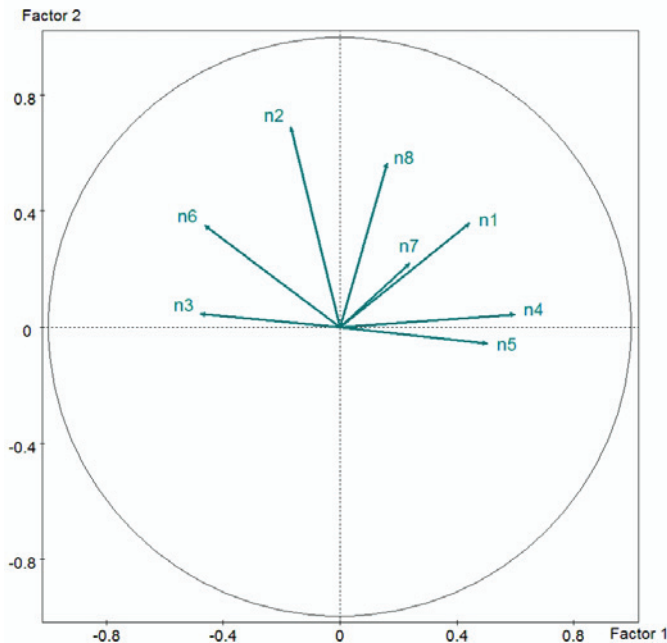


Fig.1. Correlation circle with trip intensities n_i of each trip type i (cf. table 1), describing mobility behaviours in 2008.

Mobility behaviours are then described by a vector of intensities in the previous trip typology. Namely, every individual is described by a number of trips of each type. Principal component analysis is performed on "mobilities" described by such vectors. Principal components may be interpreted through the correlation circle where active variables are pictured: here, active variables are intensities in trip profiles, where n_i represents the number of trips of type i . On the first component, trip frequencies of types 1, 4 and 5, corresponding to motorized proximity or short-scale trips, are opposed to mobilities of types 3 and 6, corresponding to proximity transit, and neighbourhood trips by soft modes. Consequently, at first glance, the first component seems to contrast highly motorized mobilities to mobilities characterized by a larger use of transit and soft modes. It is a qualitative component that could be interpreted in terms of modal split and lifestyles. On the second component, all intensities appear on the same side, revealing that the second component is purely quantitative. Highly mobile individuals face individuals with low-mobility. In 2008, this quantitative dimension is almost independent from modal split. There are highly mobile individuals with a large contribution of transit, train and soft modes. It is the case, notably, of people living in the urban area of Paris, as we shall see. On the contrary, some people have low or average mobility levels, but highly motorized. At first glance, this result may look counter-intuitive from what we know about the relationship between mobility potential and car ownership. However, independence between the intensity of mobility and modal split mainly concerns daily trips at

the proximity or short-scale level for which alternative modes are often available, especially in built-up areas. Types 2 and 8 representing week-end leisure trips by soft modes and very long-distance trips are more strongly correlated with this dimensional component, which means that a high level of mobility for leisure purposes is correlated with a general high level of mobility. Eventually, some trip intensities are not well represented on the two first components. It is particularly the case for intensity in type 7 representing long-distance trips between 80 and 400 km, that is strongly correlated with the third component. It looks like the third component could be interpreted as a *scale factor* opposing short-scale to large-scale mobilities.

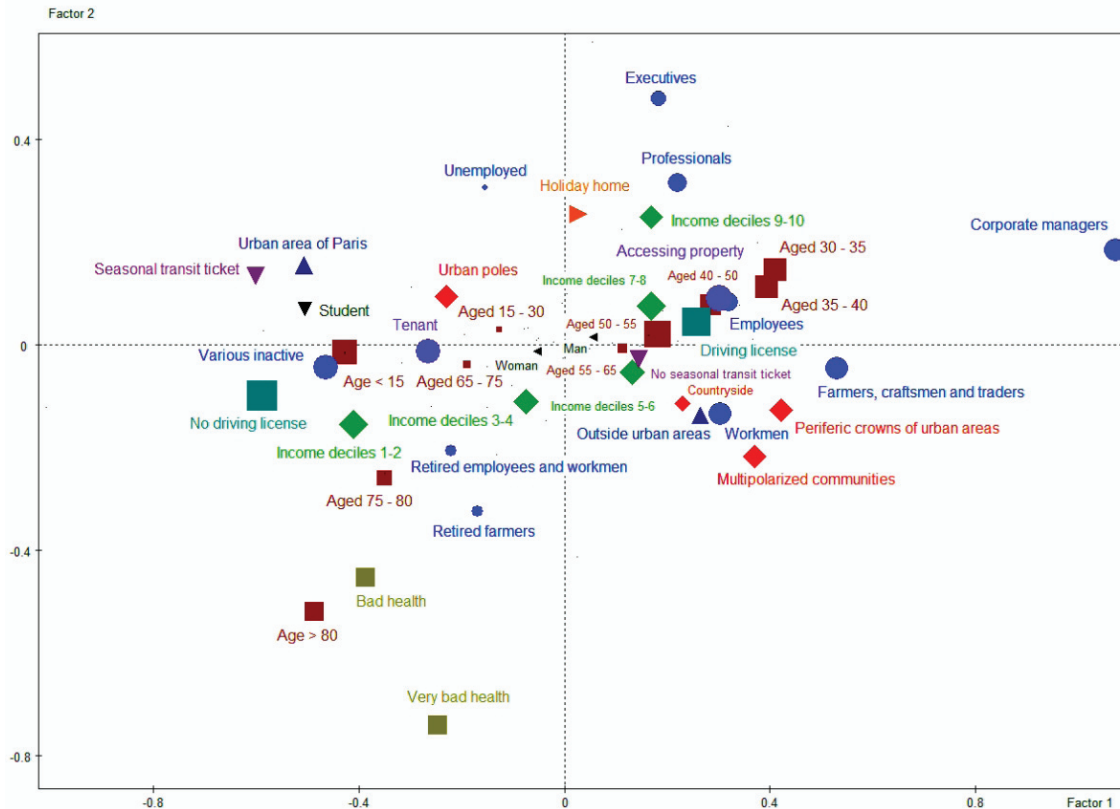


Fig. 2. Interpretation of principal components by supplementary variables in 2008: symbols and colors are conventional, only for the purpose of readability. Different symbols and/or colors correspond to different variables. Symbol sizes are proportional to their \cos^2 (illustrating their quality of representation on principal components).

Factor interpretation can be comforted by illustrative variables as shown in Fig. 2., where each modality is represented at the barycentre of individuals sharing it. On the left hand side we find all factors contributing to a weakly motorized mobility and a high modal share of alternative modes:

- Limitations to mobility resulting from age (loss of autonomy after 75), health or disabilities.
- Lack of professional trips caused by inactivity: students, retired, unemployed, and housewives. One strong result from last National Transport Surveys is the adjustment from mobility levels of retired people, catching up those of workers. Different mobility levels still remain but are now mainly caused by commuting and professional trips.

- High-density areas, land use or housing patterns correlated with the availability of alternative transport supply: the urban area of Paris, built-up areas, central districts, tenants.
- Various factors limiting access to car ownership and use and/or facilitating alternative transport: transit seasonal tickets, lack of driving license, car deprivation, no parking facilities, low income.

On the contrary, on the right hand side we find all features contributing to a highly motorized mobility:

- No health problems or disabilities.
- Professional activity inducing supplementary trips: working adults between 30 and 55.
- Household structure: couples with children.
- Low-density areas, land use or housing patterns correlated with low availability of alternative transport supply: peripheric crowns of urban areas, countryside communities, and property owning.
- Factors facilitating access to car ownership and use and/or limiting access to alternative transport: driving license holding, car ownership, and high income.

However, the income or socioprofessional factor is more strongly correlated with the second component than the first one, illustrating diversity of lifestyles within high-income groups, with respect to life cycle position and individual preferences, but also partial independence between mobility potential and car availability. The first component is much more correlated with age and activity, respective conditions of access to alternative modes, land use and housing patterns. In broad lines, the first component contrasts inactive people, either retired or students, living in high-density areas, with a strong use of transit and soft modes in their daily trips, as opposed to individuals featuring highly motorized mobility, typically families of middle-class working adults living in low-density periferic areas. This *lifestyle* dimension of mobility behaviours is quite well known. Despite its imperfection, we use the term “*lifestyle*” here as more commode, but one shouldn’t forget that different residential locations very often resulting in contrasted mobility behaviours are only chosen for a part. Notably, they are also influenced by strong constraints related to housing prices correlated with limited housing supply, encouraging migration towards periferic areas in the context of family expansion.

Second and third component, that we have interpreted as *intensity* and *scale* of mobilities, appear to be mainly correlated with activity and socio-economic position illustrated by income, socio-professional group or qualifications. Highly mobile groups face individuals subjected to mobility restrictions. Indeed, previously mentioned limitations to car use also influence the global level of mobility: downwards the second component, we find the unhealthy, the disabled, people aged more than 75, individuals living in countryside communities, or without a driving license. We also find the retired because of the lack of professional trips. Upwards, executives, professionals, highly qualified, high incomes, and owners of holiday homes represent highly mobile groups. Middle-class workers are in the central cloud. Synthetically, the second component seems to contrast individuals with mobility restrictions caused by health, disabilities, financial resources or ageing, from individuals comfortably off with a high degree of social integration, highly mobile especially for leisure purpose, both on proximity and long-distance scales. Eventually, the third component which was identified as a *scale factor* contrasts executives, highly qualified, holiday home owners, from unemployed, workmen and employees of services to individuals. Unemployed appear to be among individuals with a high level of mobility, but concentrated on the proximity level, while executives or highly qualified move on a wider scale. Consequently, it looks like socio-economic position has become more determinant for long-distance mobility, which is more expensive and therefore dependent on financial resources, than for global mobility that can be only made up of short-scale daily trips.

To make a long story short, in 2008, by order, the main dimensions of variability within mobility behaviours were the following:

- The first dimension is qualitative, and concerns the style of daily trip patterns, in terms of modal split, which is influenced by land use and housing patterns. Highly motorized mobilities of low-density, peripheric areas are opposed to inhabitants of central cities and close suburbs allowing a larger contribution of alternative modes. Contrasted mobility styles correspond to different populations: on the side of alternative transport, over-representation of the young, the elder, the poor and the well-off; on the side of hegemonic car use, over-representation of middle-class families of workers.
- The second dimension is quantitative, and related to global trip frequency, which is correlated with leisure mobility. This factor contrasts individuals depending on their activity status and socio-economic position.
- Eventually, the third dimension has been interpreted as a *scale* factor: long-distance mobility remains highly correlated with socio-economic status.

At this point, we can ask ourselves whether successive dimensions of variability among mobility behaviours and their hierarchy remain stable through long-term periods or change, and also if explanatory factors of variability also remain stable. For instance, we know from econometric modelling results that income elasticities of mobility and transport demand have been declining through long-term periods [coll. op., IFSTTAR, 2011], [Goodwin, Dargay & Hanly, 2004]. In order to answer these questions, the same methods were applied to data from National Transport Survey in 1993-1994.

4. Results of 2004 survey

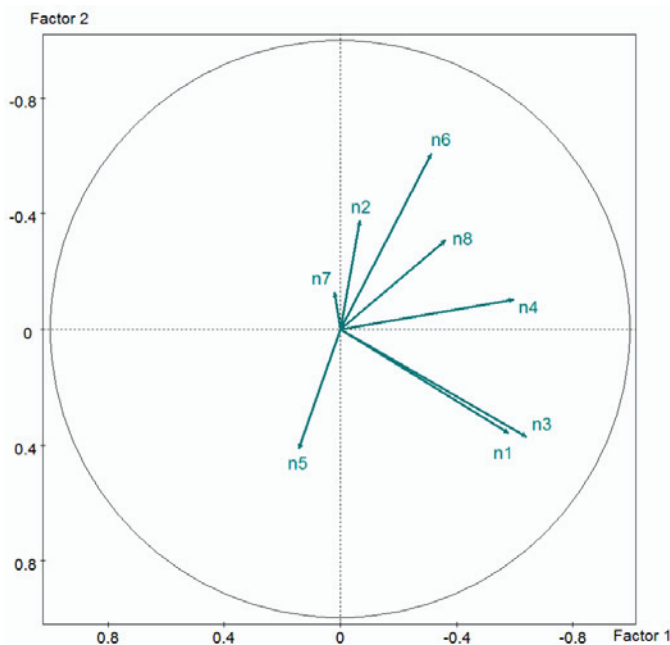


Fig. 3. Correlation circle representing trip intensities describing mobility behaviours, in 1994.

Like for National Transport Survey in 2008, a trip typology was built from multiple correspondence analysis followed by hierarchical clustering, and mobilities were characterized by intensities in respective trip types. Principal component analysis on trip intensities was then performed. On the correlation circle, almost all trip intensities appear on the right hand side of first component, illustrating that the first factor is mainly quantitative and can be interpreted as an *intensity factor*. Highly mobile individuals, on right hand side, are opposed to individuals of low mobility, on the left hand side. On the second component, intensities in trip types 1, 3 and 5 are opposed to intensities in trip types 2, 6 and 8, namely neighbourhood, proximity for personal purposes, and short-scale trips are opposed to commuting, long- and very long-distance trips. In other words, the second factor contrasts individuals with frequent commuting trips completed by long-distance occasional trips from individuals whose mobility is limited to personal purposes and restrained scales. It could be interpreted as an opposition between “active-type” and “inactive-type” mobilities.

This interpretation is comforted and enriched by supplementary variables. In the $[X_1 > 0, X_2 < 0]$ quadrant, corresponding to intense and “active-type” mobilities with the previous interpretation, we find the working occupied and the students. In the opposite quadrant ($[X_1 < 0, X_2 > 0]$), corresponding to low and “inactive-type” mobilities, we find the military, the unemployed, housewives and retired people. The second component also contrasts the urban area of Paris from countryside. Working and retired mobilities are opposed on both factors, namely both quantitatively and qualitatively. Mobility levels depending on age are partly explained by professional activity generating supplementary trips. However, in 1994, there was also a strong difference between active and retired in personal mobility, because driving license wasn't yet completely generalized among the elder. Mobility levels also strongly increased with qualifications, socioprofessional group and financial resources: the first factor can be interpreted for a part as a dimension of socio-economic hierarchy. However, variability within mobility levels also results from other factors, such as sex, or driving license holding. Like in 2008, the third component is a scale factor contrasting short-scale from larger-scale mobilities. On this component, inhabitants of low-density areas are opposed to those of metropolitan cities. Indeed, fifteen years ago, long-distance mobility was much higher among inhabitants of high-density areas, which was partly explained by location effects of socio-economic groups, executives being more concentrated in big cities (especially in the urban area of Paris), partly by differences in access to alternative transport supply.

Comparing factor hierarchy and factor correlations with illustrative variables, fifteen years apart, provides evidence of major transformations. Fifteen years ago, differences in mobility behaviours were mainly quantitative. Nowadays, they have become mainly qualitative: the main dimension of variability within mobility behaviours is now an opposition between inhabitants of low-density areas characterized by hegemonic car use, and mobilities of high-density, central areas featuring larger use of soft modes and transit. Trip frequency has only become the second dimension of variability. Mobility levels remain dependent on socio-economic position, but gaps between the poor and the well off have been declining. The same report can be made for the influence of sex, activity status, age, or the type of residential location, on global mobility levels measured by trip frequencies. For instance, mobility gaps between men and women have almost disappeared, except for professional trips. Relative homogenization may be explained for a part by generalization of driving license holding and car ownership. In particular, access to car use and ownership has increased quickly among women, retired, low-income groups, workmen, partly because of generational renewal (notably, differences between men and women in car use are clearly generational), partly because of decreasing cost of car ownership with the expansion of second-hand market. In 1994, low mobility was more strongly correlated with retirement and age, the elder frequently being license- or car-deprived. Simultaneously, mobility of young adults was often restricted to neighbourhood: this situation has changed with earlier access to individual autonomy in terms of mobility

and car ownership. As a result, low mobility or mobility restricted to very short-scale trips is now more closely associated with social exclusion or precarity.

Nonetheless, symmetrically to car generalization, car ownership and use has begun declining among executives and young adults living in metropolitan areas. Explanations for such trends are not clear yet, but high incomes might have already attained a level of saturation in car ownership and use in 1994, while lower income groups might have followed an adjustment process. If it were true, it would be a sign that market saturation has already been attained. In metropolitan areas, parking difficulties and traffic congestion might also represent serious limitations inclining city-dwellers to master car use and report on available transit alternatives. Consequently, classic socio-demographic variables such as financial resources, age or sex have lost a part of their explanatory power to forecast mobility levels. Simultaneously, types of residential location and conditions of access to alternative transport modes have become more decisive in explaining modal split. Such trends could be interpreted as signs of behavioural rationalization, in a double sense:

- Behaviours would become multimodal. Alternative modes would become considered as various and complementary services to ensure mobility, subject to systematic comparison in terms of availability, travel time, comfort, liability. This approach would substitute to a symbolic and subjective relationship to car where some modes, for instance transit, are systematically excluded.
- In some groups, mobility would restrain to necessary trips, for instance because of fuel price increase. Rationalization among the young could also proceed from growing sensitivity to sustainable development issues.

Growing correlation between alternative transport supply and mobility behaviours underlines the efficiency of alternatives to car in high-density areas, but also reveals the dramatic and sustainable lack of real solutions in low-density areas nourishing continuous traffic growth. Combined with the declining influence of socio-demographic factors on mobility levels and rationalization, it suggests the need for developing alternative and complementary approaches to understand latent determinants of mobility behaviours such as attitudes or opinions, either by stated preference surveys, market studies, or inclusion of additional questions in classic household surveys. These approaches might be useful especially for prospective and forecasting developments.

5. Meaning and implications

Mobility homogenisation can't be really interpreted as a sign of decreasing inequalities. Resulting from an adjustment process, it would rather mean that car ownership and use aren't anymore social distinctive signs. It is likely that social distinction has moved to other aspects of mobility practices. Long-distance mobility remains correlated to social position, mainly for high-speed train, which is still expensive by comparison with car use and even plane with the expansion of low-cost companies. Justification of increased high-speed train use among high incomes could be related to higher values of time. Social distinction is also maintained for buying new vehicles instead of second-hand [coll. op., IFSTTAR, 2011], and for vehicle range. Furthermore, we can't exclude that restrained car mobility could have become socially distinctive with the growing concern about sustainable development issues. Latent variables in modelling approaches might help understanding shifts in social distinctive signs and mobility cultures [Klinger, Lanzendorf, Kenworthy, 2010] caused by generational renewal, but also by car trivialization.

Indeed, works on diffusion of innovation distinguish several stages in market expansion of goods and services [Rogers, 3rd ed., 2003]. Car could have gradually moved from a superior to usual good. Homogenisation of car ownership and use provides some evidence that the adjustment process is (almost) achieved, and that transport demand is moving towards saturation, or may be decline. Several data sources suggest that the “peak travel” assumption [ITF, 2011], [Metz, 2010] is not unlikely and could represent a credible alternative scenario to the assumption of continuous growth in transport demand. Notably, successive French national transport surveys underline that some characteristics of mobility behaviours such as average daily trip frequency remain extremely stable through long-term periods. Moreover, from the early 2000’s one shall see stabilization in car traffic [CGDD, 2011], currently decorelated from national product growth. Analysis based on demographics and mobility behaviours strongly suggest that the relationship between economic *inputs* such as prices or incomes and transport demand is not direct but is filtered by mobility behaviours, demographics and land use patterns. For instance, local mobility is for a large part made of constrained trips such as house-to-work. Even long-distance mobility, more sensitive to economic inputs, presents some constant characteristics, average distance per travel remaining stable between 1994 and 2008.

Consequently, a better understanding of behavioural determinants and prospective assumptions about mobility are required to build credible scenarios about transport demand in the future. Interestingly, results from multidimensional analysis encounter works based on econometric modelling, underlining, for instance, that income elasticities of mobility and transport demand are declining, or that dynamic elasticities are different from cross-sectional elasticities [Madre & Gardes, 2005] in long-run periods. In particular, increase in the relative income effect would bring substitution of services to durables inside the same demand function, resulting in greater demand for collective transport. This theoretical approach is at least consistent with observations from national transport surveys about long-distance trips where partial substitution of train to car is observable in high-income groups. Later econometric modelling works based on both cross-sectional and panel data might help appraising economic assumptions about decreasing marginal utility, increasing value of time and substitutability between goods and services within the same demand function.

However, the possibility of market saturation [Papon & Madre, 2003] might also help understanding current trends. Market saturation could be based on the idea of an asymptotic limit for individual or household needs, though we must admit that the notion of *need* is not constant but relative to an epoch: for instance, the asymptotic limit for car ownership tends to come from one car per household to one car per individual. But this strong trend towards individualization is compensated by rationalization. This double process defined by individualization and rationalization that we could synthetically qualify as behavioural “*modernization*” could provide a global framework to assess the plausible limit of need saturation that would remain dependent on demography, land use patterns, work participation and household structure.

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